

## LIQUID SPRAY DEVICE AND CUTTING METHOD

### TECHNICAL FIELD

The present invention relates to a liquid spray device for feeding spray (liquid particulates) in a container to spray liquid to a target object and a cutting method using the same. More particularly, the present invention relates to a liquid spray device for supplying a cutting member of a machine tool, for example, a machining center, a grinding machine, a turning machine, or the like, with a cutting oil and to a cutting method using the same.

### BACKGROUND ART

Hitherto, during machining, oil is sprayed to a target object, for example, a work piece or a tool, etc., in order to enhance the machining accuracy or to extend the life of tools. In a method of directly spraying liquid oil to the target object, the amount to be sprayed becomes too large, so that it takes a long time to remove excess oil, thus reducing the productivity. Furthermore, since the excess oil scatters around the device, it has been necessary to prevent the working environment from being contaminated.

When oil is sprayed in the form of oil droplets, since a machining operation can be performed with only the necessary minimum amount of oil, it is possible not only to improve the process accuracy or productivity, but also to improve the working environment, thus simplifying plant and equipment. JP5-92596U proposes one example of a device capable of spraying oil in the form of oil droplets.

However, in the above-mentioned oil supplying device, it is necessary to provide a spray producing part with a casing for an oil dropping part, a path for fast-speed gas, a Venturi nozzle, and the like. Furthermore, a pump and an oil vessel are formed separately from the main body, thus making the structure of the spray device complicated.

Furthermore, in the above-mentioned oil supplying device, an internal pressure of the main body is dependent upon a primary supply pressure and a hole diameter (a cross-sectional area) of a tip spray injection part. Consequently, as the hole diameter of the spray injecting part is changed, the internal pressure of the main body changes accordingly. Therefore, when, for example, a tool provided with a discharging port is used as the spray injection part, if the tool is replaced with one having a smaller hole diameter, the internal pressure of the main body is increased. In this case, the flow velocity of spray injection can be secured without any problems. However, since the difference between the primary supply pressure and the internal pressure of the main body is reduced, a sufficient amount of spray may not be produced effectively at a spray production part.

On the contrary, if the tool is replaced with one having a larger hole diameter, the internal pressure of the main body is reduced. In this case, it is possible to secure the difference between the primary supply pressure and the internal pressure of the main body. Therefore, there is no problem in producing spray effectively. However, occasionally, the flow velocity of injection cannot be secured sufficiently. Actually, a number of production plants employ unmanned operation. Therefore, it is impossible to adjust the supply pressure every time the hole diameter of injection is changed.

### DISCLOSURE OF INVENTION

It is an object of the present invention to provide a liquid spray device capable of reliably producing a fine spray

stably with a simple structure and of securing a flow velocity of injecting spray and a cutting method using the same.

In order to attain the above-mentioned object, a first liquid spray device according to the present invention includes a container, a spray injection nozzle for injecting oil spray into the container, a spray feeding path for feeding oil spray in the container to the outside of the container, wherein liquid is stored in the container, and an under-liquid nozzle having a gas exhaust port in the liquid and producing spray by supplying gas into the liquid is provided.

With such a liquid spray device, the use of the under-liquid nozzle can enhance the internal pressure of the container and produce spray in addition to the spray produced by the spray injection nozzle. Thus, it is possible to increase the flow velocity of spray at the exit of the spray feeding path and to increase the amount of spray.

It is preferable in the first liquid spray device that most of the injected spray flow from the spray injection nozzle is allowed to strike the wall face of the container before being fed to the spray feeding path. With such a preferred liquid spray device, since oil spray having a large diameter or oil droplet is easily attached to the wall face, it is possible to prevent the oil spray having a large diameter or oil droplet from entering the spray feeding pipe.

Furthermore, it is preferable that the wall face is a liquid surface of the liquid. With such a liquid spray device, since oil spray having a large diameter or oil droplet is easily absorbed by the liquid surface when striking the liquid surface, it is possible to prevent the oil spray having a large diameter or oil droplet from entering the spray feeding pipe.

Furthermore, it is preferable that the liquid spray device further includes a pressure controlling means for keeping the pressure in the container constant in a path for supplying the gas to the under-liquid nozzle. When the internal pressure of the container is constant, the difference between the primary pressure of the gas supplied to the container and the internal pressure of the container becomes constant, the flow velocity of the gas in the container for spraying is also constant, and thus stable production of spray can be realized. Furthermore, also at the discharging part, since the constant flow velocity can be secured, it is possible to discharge oil spray by converting the oil spray into the oil droplets.

Furthermore, it is preferable that the liquid spray device further includes a gas discharge nozzle having a tip in the air inside the container and discharging gas. With such a liquid spray device, since the internal pressure of the container can be increased, it is possible to increase the flow velocity at the exit part of the spray feeding path.

Furthermore, it is preferable that the liquid spray device further includes a pressure controlling means for keeping the pressure in the container constant for feeding gas into a path for supplying the gas to the gas discharge nozzle. If the internal pressure for feeding gas into the container is constant, the difference between the primary pressure in the container and the internal pressure of the container becomes constant. As a result, the flow velocity of the gas for producing spray in the container is also constant, thus realizing the stable production of spray. Furthermore, it is possible to obtain the constant flow velocity also at the discharge part, and it is possible to discharge spray in the form of oil droplets.

Furthermore, it is preferable that a tip-tapered discharge part is connected to the tip of the spray feeding path. With such a liquid spray device, the flow velocity of spray at the discharge part is increased, and it is possible to take out the spray in the form of oil droplets.